TEXTILE RESEARCH

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TEXTILE RESEARCH

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Outstanding Features in

This Month's Issue

Committee for Economic Development

Organized by industry and self financed, the new Committee for Economic Development which is composed of men of outstanding accomplishment, is a working organization to assist Government and industry in preparing to make their full contribution to stability and prosperity when peace comes. (See page 2.)

Classification of Fibers

A practical plan for the grouping of man-made fibers under descriptive classifications, was presented by H. R. Mauersberger at a recent meeting of the American Society for Testing Materials. (See page 10.)

Advantage of a Sheet with Blanket

For outdoor use where protection against the wind and other elements is important, as in an open lifeboat at sea, a combination of a blanket and sheet will afford far more protection than the blanket alone. (See page 13.)

Storage of Textiles

Under certain conditions of storage textile fabrics showed significant deterioration. Results of tests carried out over a period of four years at the Bureau of Human Nutrition and Home Economics indicate the manner in which goods should be stored in order to obtain a minimum of damage. (See page 20.)

Industry Assists Private Enterprise System Through Organization of

Committee for Economic Development

"THE FUTURE OF AMERICAN ENTERPRISE is now in the making. For some time we have been engaged in passing from a peacetime to a war economy, and certain basic economic facts flowing from this transition are mapping out the pathways of tomorrow.

"A few objections to doing postwar planning now have been raised in some quarters. For example:

'Let's win the war first.'

'We can't plan now—we don't know what will happen in the future.'

'We don't have the time.'

'Our company is different.'

"It would be easy enough to answer these objections by replying that defeatism brings its own reward, defeat. But there is a stronger answer. These objections themselves point up the basic fact that there is no alternative to planning for high production and employment levels other than defeat.

"It is the studied opinion of those qualified to judge that if we defer winning the peace until after we have won the war, our freedom will be placed in great jeopardy. Unless we start NOW working on a program to provide jobs—millions of them—in peacetime industries in the shortest possible space of time after hostilities cease, we will have mass unemployment for too long a period. History shows clearly that if there is too much unemployment for too long a time, and Germany and Italy are two good examples, a free society gives way to dictatorship. The peace most certainly will have been lost, if—in the postwar period—our free society is supplanted by a regime of regimentation."

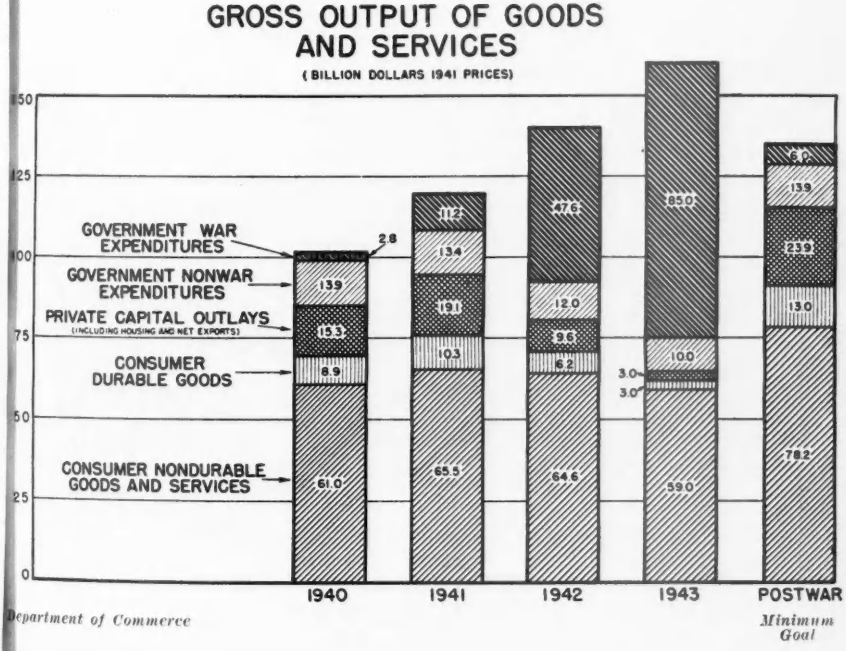
The above statements appear in the "Hand-book

For Employers" just issued by the Field Development Division of the Committee for Economic Development. Further description and statement of objectives follows:

"The Committee for Economic Development is an independent, private, non-profit corporation financed entirely by contributions from individual businesses.

"This Committee has been organized to assist Government and industry in preparing to make their full contribution to stability and prosperity, through high levels of employment and productivity, when peace comes.

"That the successful prosecution of the war is the first concern and paramount obligation of commerce and industry is the belief of the members of the Committee. They are convinced none the less that the most commerce and industry can do now to assure returning soldiers and workers presently engaged in war industries that peacetime jobs will be available is the *least* which must be done if enterprise and labor are to enjoy a free society."



Department of Commerce

The Committee is neither an official nor a semi-official agency of government. It is completely independent and self financed. But, it has the active support of Secretary of Commerce Jesse H. Jones and has been assured hearty cooperation by every government agency concerned with problems of the postwar economy.

Outstanding men comprise the personnel of this Committee as will be seen from the accompanying chart. That it is to be a committee for accomplishment and not merely in name and on paper, will be readily understood by reading this published "Hand-Book" * which should be studied by every business executive. It is in four parts.

Part 1 describes the organization and objectives of the Committee.

Part 2 has for its subject how to proceed with postwar planning. Some of the topics discussed are: Determination of Your Company's Objectives; Procedure Involved in Approaching Postwar Planning; Estimating Your Share of the Postwar Production; Acting on Your Plans; Guidance for Changing Conditions; and a number of case histories are given indicating what some leading companies are doing to deal with these problems.

Part 3, "Postwar Questions Worth Posing Now" discusses product development, production, purchasing, financing and accounting, marketing and distribution, personnel, general policy and some objections and answers.

Part 4, Some Suggested Readings.

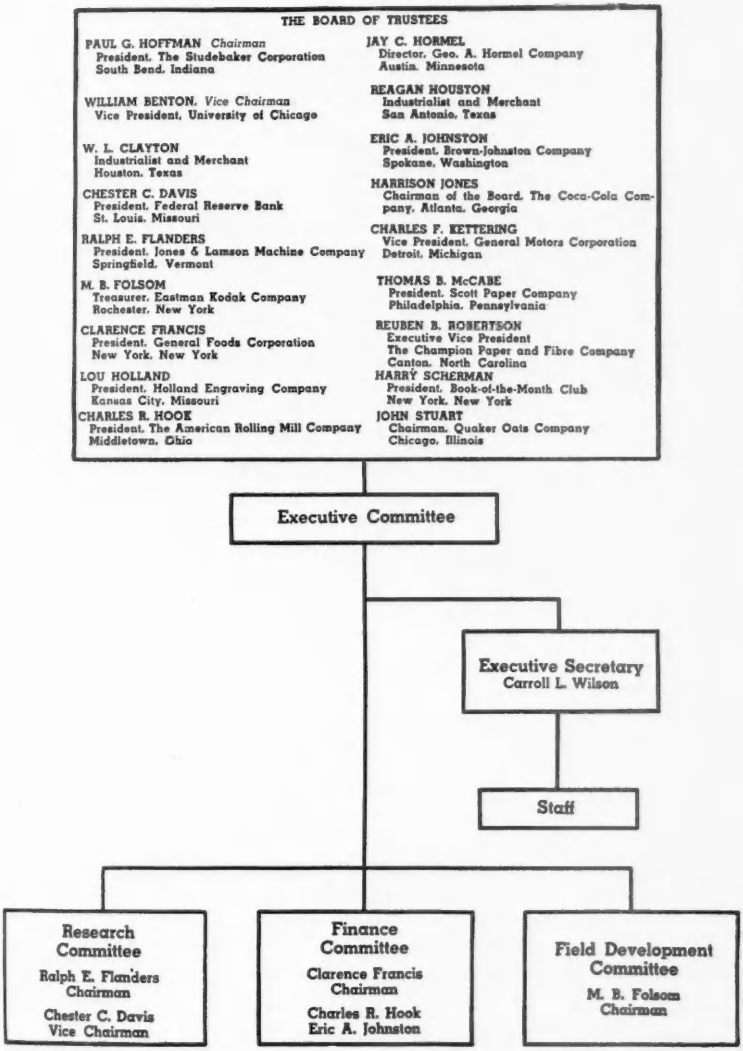
"With the coming of peace, our Government will no longer be in the market for 85 billion dollars worth of war goods. A minimum of 7 million men in the armed services and most of the 20 million persons now in the war industry will be returning to peacetime pursuits, eager for productive work. Planning is not new to industry; no company has grown without careful planning;

* This Hand-Book, "PREPARING FOR HIGH LEVELS OF EMPLOYMENT AND PRODUCTIVITY: HANDBOOK FOR EMPLOYERS," and any additional information, may be had by writing to the Committee for Economic Development, Field Development Division, Room 3311, United States Department of Commerce Building, Washington, D. C.

and today is the time when its own interest dictates that every company plan its future development beyond as well as up to the postwar period.

"There is no time to lose."

Organization Chart of Committee for Economic Development.



Textile Research Institute, Inc.
Adds to Its Staff

Malcolm E. Campbell

The rapidly expanding research program of the Textile Research Institute, Inc., has led to the appointment to the staff Malcolm E. Campbell, who is widely known in the field of textile technology.

For some years Mr. Campbell has directed the fiber and spinning research program of the Cotton and Fiber Branch of the United States Department of Agriculture —covering work conducted in the laboratories at Clemson College, Texas A. and M. College, Stoneville, Miss., and Washington, D. C. He is a graduate of the New Bedford Textile School and also of Clemson College, where he taught textile engineering for three years. His experience includes work in several New Bedford Mills and a year with the cotton testing department of the Firestone Tire and Rubber Company of Akron, Ohio.

In 1935 Mr. Campbell was sent abroad by the Government to investigate the status of textile research in six countries—returning to direct the establishment and expansion of the laboratories at Texas A. and M. College and Clemson College respectively. He has conducted a number of important processing tests for the Department of Agriculture and has recently concluded a study—which will be of much interest to cotton manufacturers—on the influence of cotton combing on the quality of yarn and on the economies of cotton manufacturing. This research will shortly be published under the title of "The Effects of Varying Percentages of Comber Waste on the Quality of Cotton Yarn."

Mr. Campbell's new duties will include the organization and supervision of applied and cooperative research activities, including important processing research projects—covering cotton, wool and synthetics—recently rec-

Malcolm E. Campbell, New Member of the Staff of Textile Research Institute, Inc.

ommended by the technical research committee of the Institute. He will keep in close touch with members of the Institute and their problems and work closely with the president on the organization of group or sectional meetings in different branches of the industry to deal with specific research problems. He will also have the benefit of close association and cooperation with the fundamental research work being conducted by the research associates of the Textile Foundation and Textile Research Institute under Dr. Milton Harris at the National Bureau of Standards in Washington. This includes also the facilities of the newly organized Research Information Service recently set up under the direction of Dr. Harris. Mr. Campbell's headquarters will be at the New York offices of the Institute.

RESEARCH ACTIVITIES

The annual Academy award for 1942 by the Washington Academy of Sciences "For Outstanding Work in the Physical Sciences" has been given to Dr. Milton Harris, director of research for the Textile Foundation and Textile Research Institute, Inc. The announcement of the award made at the annual meeting of the Society held March 18, 1943 in Washington, carried the citation: "For Distinguished Work on the Chemistry and Structure of Fibers."

Bureau of Human Nutrition and Home Economics is the new name of the Bureau of Home Economics of the Department of Agriculture.

A new process for rendering camouflage fabrics of rayon proof against detection through infra-red photography was recently reported in the Daily News Record. This process was developed by Dr. Henry A. Gardner, director of the scientific section of the National Paint, Varnish and Lacquer Association, Washington. The incorporation of a special pigment in the rayon spinning solution causes the rayon to reflect the infra-red rays in the same manner as do living plants, and foliage.

American Association of Textile Technologists has issued a complete roster of its members in booklet form. In addition to listing the names, addresses and business connections of all of the members, these are classified as to the branch of the industry with which they are associated.

Treating clothes with a chemical making the garments shed water and resist stain may soon be a common operation for dry cleaners and laundries, the Fine Chemicals Division of E. I. du Pont de Nemours & Company recently announced. Clothes are made water and stain resistant by dipping them in a

solution after washing or dry cleaning. The chemical treatment of the fabric cannot be seen or felt, has no odor, and does not impair the appearance or draping qualities of the garment.

Dr. Wanda K. Farr has joined the research staff of the Celanese Corp. of America with headquarters at the company's plant at Cumberland, Md.

Stronger and less irritating to the body's tissues, nylon has proved a superior replacement for silk in sutures. It will not dry out and rot like the natural fiber, and, therefore, quantities are being made for storage at United Nations' medical depots throughout the world. Nylon has greater tensile strength than silk and can be produced in controlled, uniform diameters.

Dr. Milton Harris, director of research for the Textile Research Institute and Textile Foundation, spoke at a dinner meeting of the North Carolina section of the American Chemical Society, at Hotel Charlotte, March 25. The subject of Dr. Harris' talk was "Some Concepts of Textile Fibers."

A patent relating to the removal of creases from fabrics containing thermoplastic material, such as cellulose acetate, was recently granted to Celanese Corporation of America. According to the invention—United States Letters Patent Number 2,313,173—creases are easily and permanently removed from cellulose acetate fabrics if the creased fabrics are stretched and then subjected to a temperature of from 250 to 900 degrees Fahrenheit for 0.1 to 15 seconds while they are in the stretched condition. The fabric being treated should contain no more than its normal moisture content and is passed in close proximity to, but not in contact with, the heated surface or other source of heat.

H. R. Mauersberger Presents to A.S.T.M. Suggestion for Classification of

Man-made Fibers

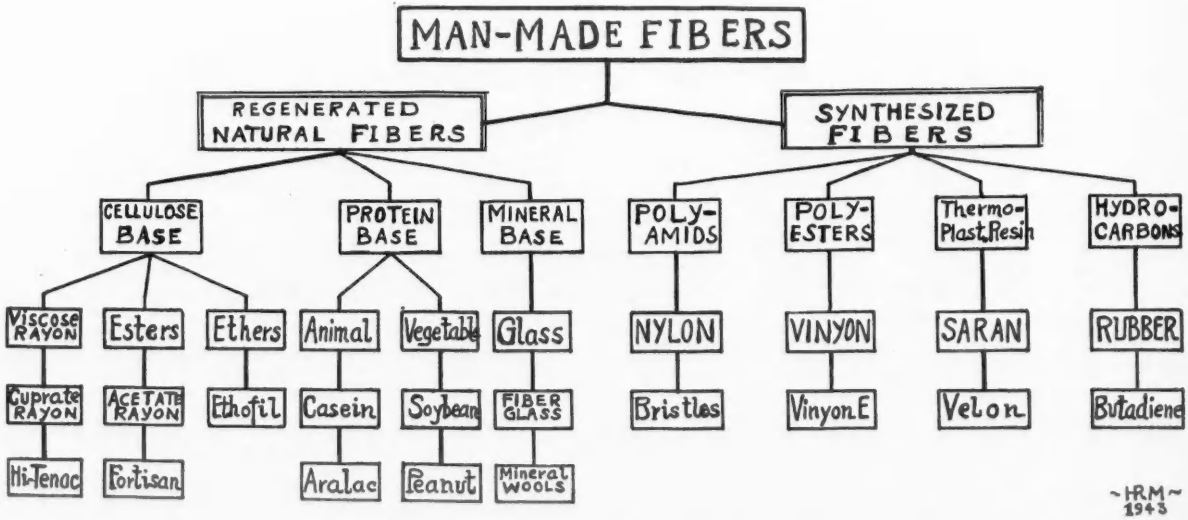
AT THE PAPERS SESSION of the recent meetings of Committee D–13 of American Society for Testing Materials held in New York, a paper was read by H. R. Mauersberger, technical editor of *Rayon Textile Monthly*. In this paper, entitled "Progress in New Synthetic Textile Fibers," Mr. Mauersberger presented a plan for the classification of man-made fibers which, if generally adopted, would do much to clarify the existing confusion in nomenclature. Mr. Mauersberger's presentation is given in part below:

"In the last few years, it has become more and more apparent to me and others that the word "synthetic" is not the best nor an all inclusive word for the fibers I have discussed, but has been used for lack of another or more suitable word or words. From my observations, study and research, it has become very clear to me, at least, that we have now two distinct types or groups of man-made fibers, which I want to call to your attention today.

"One large group distinctly derives from natural sources such as wood pulp, cotton linters, cow's milk, soybeans, peanuts and silicate glass. I would like to term these REGENERATED NATURAL FIBERS.

"In the second main group of man-made fibers, would belong all filaments and fibers produced by a combination of elementary or complex chemicals through synthesis, polymerization, copolymerization, heat treatments, stretch and setting operations, all of which are complicated, strictly chemical processes as nylon, Vinyon, Saran, Velon synthetic rubber. I suggest SYNTHESIZED FIBERS for this group, instead of synthetic fibers, although the latter could be used justifiably.

"This classification separates the main products and subordinates none. I recommend it to you for consideration and adoption by Committee D–13."



Suggested nomenclature for man-made fibers.

Low Grade Cottons Can Be Satisfactory Reinforcement For Plastics Indicated by Data on

Tensile Strength of Cotton Fiber

THERE APPEARED in the February 1943 issue of TEXTILE RESEARCH an article entitled, "Strength of Cotton Fiber Bundles" based on a letter from Dr. R. W. Webb of the U. S. Dept. of Agriculture.

In view of the possibilities for use of unwoven cotton fiber as a reinforcement for plastics by means of a new process,* we are re-running, in part, a paragraph from this letter. The addition of two words (in italics) are important, since all commercially grown cottons are exposed to weather factors to some extent.

"In light of our large volume of data, we feel that the value, which Matthews has reported for the strength of cotton fibers is extremely low for cotton in the accepted sense; i.e. cotton which has not been allowed to deteriorate *unduly* or be damaged *excessively* by the action of light, weather, micro-organisms, chemicals, or other agencies. On the type of cotton that makes up the bulk of the American crop, we have obtained an average strength value around 80,000 lbs. per sq. in." Some cottons of this type have been observed to test as high as 106,000 pounds per square inch."

The following paragraph contains additional information from a recent letter received from Dr. Webb:

"For American upland white cotton, data show that fiber strength is, on the average, about the same from the short to medium staples and that low grade cottons possess fiber strength about as high as that of high grades, or only slightly lower. Thus, cotton fibers in general offer good technical and economical possibilities as a reinforcement for plastics."

* "Plastic Bonded Cotton Fiber," M. A. Goldman and Gerner A. Olsen. TEXTILE RESEARCH, Dec., 1942, p. 25–32.

Tests Indicate Improved Warmth For Outdoor Use Results From a

Combination of Sheet with Blanket

GENERALLY OVERLOOKED has been the fact that combining a sheet with a blanket will materially lower the thermal conductivity and, conversely, add much to the warmth, especially in moving air. Tests conducted at the National Bureau of Standards and U. S. Testing Co., and reported [1] by Dr. H. F. Schiefer, physicist at the Bureau show that for outdoor use where protection against the wind and rain is important, as in an open lifeboat at sea, a combination of a blanket and sheet or wind resistant cloth would afford far more protection than a blanket alone.

It is also concluded that such a combination would permit the use of a medium weight blanket and that the blanket need not be greatly felted. The combination would not only be more flexible and easier to wrap around the body, but would also be much warmer in a strong breeze. The sheet would provide additional strength, 60 pounds or more per inch of width, and it could be made water repellant.

In these studies five all-wool blankets that differed very greatly in air permeability were selected for systematic testing in combination with one and two sheets. Their properties were measured when new and also after 1, 5, and 10 washings. Twenty-two additional blankets and combinations of these blankets with one and two sheets were measured for thermal transmission only.

The results of the tests are given in Table I. The following conclusions may be drawn from them.

The air permeability of the combination of a blanket and one or two sheets was found to be practically independent of the air permeability of the blanket and was

[1] The Advantages of a Blanket-and-Sheet Combination for Outdoor Use. *Journal of Research, Nat. Bu. of Standards,* March 1943.

TABLE I. Results of tests on 5 all-wool blankets

Blanket	Number of Washings	Weight	Thickness at		Compressibility[a]	Compressional Resilience[b]	Breaking Strength (Grab)		Shrinkage		Air Permeability[c] Ft³/(min × ft²) at ½" H₂O Pres.			Thermal Transmission, BTU/(°F × hr × Ft²)[d]							
			0.1 lb/in²	1.0 lb/in²			W.	F.	W.	F.	Blanket alone	Sheet No. 1 under blanket	Sheet No. 2 over and Sheet No. 1 under blanket	Blanket alone	Sheet under blanket	Sheet over blanket	Sheet over and under blanket	Blanket alone		Blanket between two sheets	
																		Still air	Moving air[e]	Still air	Moving air[e]
		oz/yd²	in.	in.	in²/lb	%	lb.	lb.	%	%											
A	0	12.6	0.231	0.122	0.34	47	37	39	—	—	498	19	11	0.74	0.71	0.62	0.61	0.80*	1.74*	0.77*	1.03*
	1	13.9	.238	.147	.29	49	52	53	6	0	427	19	11	.74	—	—	—	—	—	—	—
	10	13.8	.265	.155	.32	46	53	61	12	0	435	19	11	.72	—	—	—	—	—	—	—
B	0	9.8	.193	.102	.40	50	34	13	—	–	326	18	10	.82	—	—	.66	.86*	1.95*	.81*	1.13*
	1	10.6	.183	.112	.31	51	43	27	5	3	257	18	10	.86	—	—	—	—	—	—	—
	10	11.3	.173	.107	.28	51	38	30	7	5	242	19	10	.81	—	—	—	—	—	—	—
C	0	14.9	.230	.128	.37	50	56	36	—	–	212	18	10	.78	.73	—	.62	.78*	1.91*	.76*	1.06*
	1	15.4	.261	.150	.38	50	59	35	3	1	192	18	10	.74	—	—	—	—	—	—	—
	10	17.3	.265	.173	.29	49	66	43	8	3	183	19	11	.73	—	—	—	—	—	—	—
D	0	14.7	.233	.157	.28	50	56	48	—	–	127	17	10	.82	.76	—	.66	.79*	1.38*	.74*	1.00*
	1	16.1	.216	.167	.18	52	74	60	4	6	99	16	10	.82	—	—	—	—	—	—	—
	10	18.0	.215	.163	.18	53	79	75	10	9	92	16	10	.78	—	—	—	—	—	—	—
E	0	16.5	.151	.100	.22	48	68	71	—	–	45	13	8	.95	.88	.79	.77	1.00*	1.64*	.88*	1.20*
	1	17.5	.171	.121	.23	54	68	70	6	3	41	12	8	.95	—	—	—	—	—	—	—
	10	18.1	.167	.119	.19	52	68	77	8	3	41	12	8	.89	—	—	—	—	—	—	—

[a] A high value for compressibility indicates a greater amount of napping and less felting.

[b] A high value for compressional resilience indicates greater ability of the blanket to return to its initial state upon release of a compressive load.

[c] The values for Sheet No. 1, Sheet No. 2, and the combination of Sheet No. 1 and No. 2 were 19, 23, and 10 respectively.

[d] A low value for the thermal transmission indicates a higher insulating value. The value for the sheet alone was 1.36. The asterisk indicates that the value was obtained by the U. S. Testing Company, Inc.

[e] The speed of the moving air was 15 miles per hour.

equal to or slightly less than that of the sheet or sheets alone.

The thermal transmission in still air decreased considerably when one or two sheets were used in combination with a blanket. The average decrease in thermal transmission for all of the blankets tested was 7 percent when the sheet was used under the blankets, 15 percent when the sheet was used over the blanket, and 19 percent when the blanket was used between the two sheets. The results obtained at the U. S. Testing Company did not show as marked a decrease when the tests were made in

Fig. 2. Air permeability instrument used at National Bureau of Standards, measures the volume of air passing through one square foot of fabric per minute when the pressure drop across the blanket is equal to 0.5 inch of water. The operation of this instrument is described in TEXTILE RESEARCH, **May 1942.**

still air. However, the thermal transmission of the blankets between two sheets, tested in air moving at 15 miles per hour, decreased an average of 60 percent and the value for the most permeable blanket was less than that of the least permeable and heaviest blankets. The thermal transmission of the blankets when tested alone in moving air was over 100 percent greater than when

they were tested in still air. The thermal transmission of the blankets when tested between two sheets in moving air was only 37 percent greater than when the combination was tested in still air.

The thermal transmission values obtained at the U. S. Testing Co., are consistently higher than those obtained at the National Bureau of Standards. The higher values probably result because the heat loss from the sides of the hood, which are continually exposed to moving air, is greater than that which is lost when the hood is in still air. A slight leakage of air into the inside of the hood may also contribute to the observed differences.

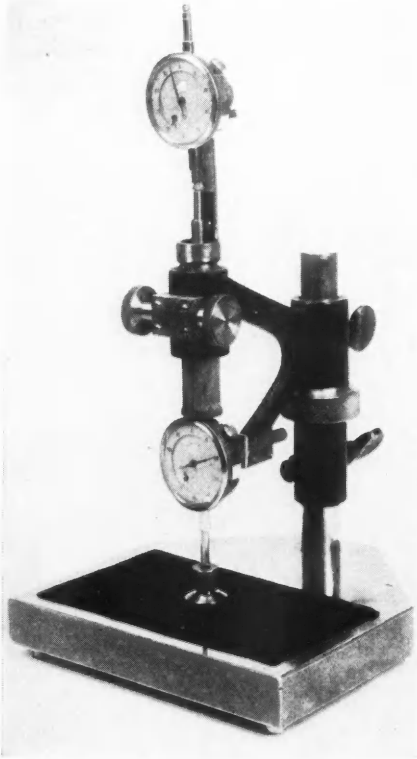


Fig. 1. Compressometer used at National Bureau of Standards for evaluating the thickness, compressibility and compressional resilience of textiles and similar materials.

The weight, thickness, and breaking strength of the blankets increased with the number of washings, and the compressibility and air permeability decreased. These changes are attributed to the shrinkages of the blankets during laundering. The compressional resilience of these blankets and the air permeability of the combination of a blanket and one or two sheets were not affected significantly by the number of washings.

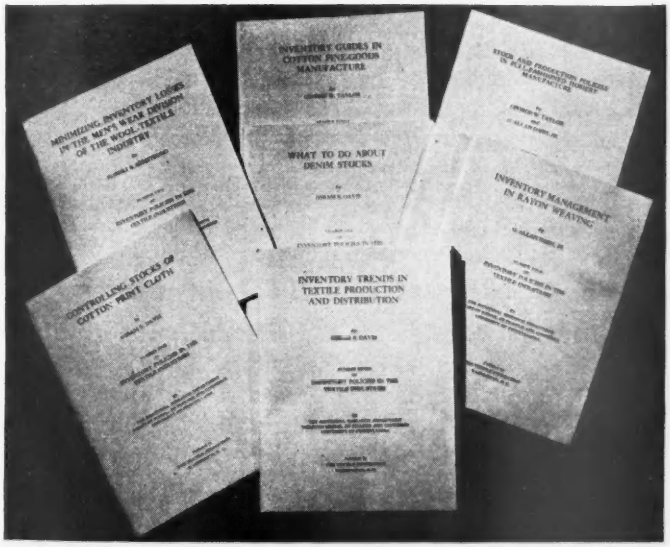
RESEARCH AIDS

Monographs on Inventory Policies

EVERY DAY THAT PASSES brings us nearer the painful process of transition from a war-time to a peace-time economy. The flood of orders will turn into a torrent of deferments, requests for contract cancellations, and other well known devices for shifting the inventory load. Sooner or later we will be obliged to look for buyers again. What are we going to do about production? What kind of an inventory policy are we going to have then? Can mills reduce inventory load by manufacturing only to order? Do textile statistics have forecasting value? How much stock does it take to carry on the textile business? Do inventory accumulations cause the ups and downs of business?

Such questions are answered in the series of seven reports prepared for the Textile Foundation by the Industrial Research Department of the University of Pennsylvania and published in 1941. The reports analyze

Series of seven reports on inventory policies.


MINIMIZING INVENTORY LOSSES IN THE MEN'S WEAR DIVISION OF THE WOOL TEXTILE INDUSTRY
INVENTORY GUIDES IN COTTON PIECE-GOODS MANUFACTURE
WHAT TO DO ABOUT DENIM STOCKS
CONTROLLING STOCKS OF COTTON PRINT CLOTH
INVENTORY TRENDS IN TEXTILE PRODUCTION AND DISTRIBUTION
INVENTORY MANAGEMENT IN RAYON WEAVING

the mistakes of the 1930's and present suggestions for the management of inventories during the 1940's.

In the last monograph, No. 7, is a check list of all the factors that are important in determining inventory policy; discussions of statistical guides, inventory trends and policies, as well as some economic implications to textiles and related industries are all pointed up here.

Titles of Monographs on Inventory Policies

1. **What to do About Denim Stocks**—A Case Study of Inventory Problems in the Manufacture of Staple Finished Goods.
2. **Minimizing Inventory Losses in the Men's Wear Division of the Wool-Textile Industry**—An Appraisal of the Policy of Manufacturing Styled Finished Goods to Order.
3. **Inventory Guides in Cotton Fine-Goods Manufacture**—An Analysis of Mill Experience in Producing Staple and Styled Gray Goods.
4. **Inventory Management in Rayon Weaving**—A Comparative Analysis of the Policies of Selling Styled and Staple Gray Goods from Stock and from Production.
5. **Controlling Stocks of Cotton Print Cloth**—Some Problems of Inventory Management in the Manufacture of Multi-Purpose Gray Goods.
6. **Stock and Production Policies in Full-Fashioned Hosiery** Manufacture—The Experience of Textile Mills Selling a Consumer Product.
7. **Inventory Trends in Textile Production and Distribution**—An Appraisal of Experience During the 1930's.

The series of seven monographs may be obtained for $3.00 (single copies 50¢ each) by addressing the Textile Foundation, 10 E. 40th Street, New York, N. Y.

The Chemistry of Natural Coloring Matters*

THE ESSENTIAL DATA on the constitutions, properties and biological relations of all the known natural pigments and related substances are presented in this 354 page volume compiled by the late Fritz Mayer, professor of chemistry, University of Frankfort-on-Main and translated by A. H. Cook of the department of chemistry, Imperial College of Science, London.

Many of the substances described such as vitamins A and K, the carotinoids, anthracenes, chlorophyll, riboflavin, hemin, and the flavones are the forefront of modern biological research. The basic information, extensively documented, which is provided in this volume will therefore be of the greatest interest to bio-chemists, dye technologists, and students of organic structure. Fully discussed also are such well-known coloring matters as indigo, alizarin, and the anthocyanins, also the insect dyes, and the pigments of fungi, molds, rare woods, and other materials.

Special efforts have been made to include the latest information available, in spite of inevitable delays due to the interference with foreign communications occasioned by the war.

* The Chemistry of Natural Coloring Matters. Fritz Mayer, *Reinhold Pub. Co., 330 W. 42nd St. New York. 354 pp. Price $10.00.*

High Polymers*

Of great and increasing importance for the chemist, the technologist and the biologist, is the study of High Polymers. "Natural and Synthetic High Polymers," written by Kurt H. Meyer, Ph.D., professor of organic chemistry, University of Geneva, Geneva, Switzerland, and edited by H. Mark of the Brooklyn Polytechnic Institute, discusses the subject from the point of view of developments in science in recent years.

Of particular interest to workers in textile research are the sections devoted to a detailed discussion of cellulose—its constitution, structure, modes of reaction, compounds and derivatives; starch and related carbohydrates; and the proteins, with particular attention given to fibrillar proteins.

Well illustrated and with frequent description of the findings of various investigators this book is not so extremely technical that it can not be understood by any one with some knowledge of chemistry and of physics. It is a theoretical treatment intended to stimulate further investigation both theoretical and experimental.

* Natural and Synthetic High Polymers. Kurt H. Meyer, *Interscience Publishers, Inc., 215 Fourth Ave., New York, N. Y. 690 pp. Price $11.00.*

Extended Tests Under Various Storage Conditions Reveal

Effect of Storage On Fabrics

By RUTH ELMQUIST ROGERS* AND MARGARET HAYS*

There has existed little knowledge regarding the extent of damage to fabrics under varying conditions of storage. Tests were carried out over a period of 48 months at the Bureau of Human Nutrition and Home Economics upon samples of a cotton, a linen and a wool fabric stored at room temperature (78° F.), also at 102° F. to simulate attic conditions in summer. The effect of storage in the dark as well as exposure to diffused light were studied.

The damage did not appear to be sufficient to render the fabrics unmarketable. Nevertheless there was a significant deterioration in certain instances. All tests indicated that both new and desized cotton sheeting were significantly more deteriorated when stored at high temperature than at room temperature and that there was definitely more deterioration in the new cotton sheeting than in the desized material. Diffused light caused chemical deterioration according to fluidity measurement for cotton and linen and to cystine sulfur for wool. The period of storage, if at room temperature, was not a particularly important factor.

As a result of this study the authors recommend that fabrics be stored in the dark, at moderate temperatures, and free of finishing material. (Editor.)

* Ruth Elmquist Rogers, textile chemist, and Margaret B. Hays, textile physicist, Bureau of Human Nutrition and Home Economics, Agricutural Research Administration, U. S. Department of Agriculture.[1] The full title of this report is: "The Effect of Various Storage Conditions Upon a Cotton, a Linen, and a Wool Fabric."

[1] Appreciation is expressed to Helen G. Wheeler, formerly Assistant Scientific Aide, Bureau of Home Economics, for laboratory assistance in this study.

THE U. S. BUREAU OF HUMAN NUTRITION AND HOME ECONOMICS receives frequent inquiries concerning methods of storing textiles, particularly now that civilian clothing of men and women in the Armed Forces as well as larger quantities of household textiles is being stored. The study reported here on the effect of certain storage conditions over a period of 4 years upon a cotton, a linen, and a wool cloth was undertaken to help answer these inquiries.

Very little work has been done on the effect of storage on textiles. Ahmad [1] [2] compared the strength of yarns made of unstored cotton and of cotton held in a shed and in an open yard at Karachi, India. During the rainy season the bales in the yard were covered with a tarpaulin. Storage up to 18 months had no effect on fiber length or weight. Bales stored in the yard made weaker yarns than those stored inside the shed, but all yarns from cotton stored under both conditions were stronger than those from the unstored cotton. Ahmad obtained high values at the end of the rainy season (6 and 18 months), and low values at the end of the dry season (0 and 12 months).

Nayak [2] found no significant change in weight, length, and strength of cotton fiber stored 3½ years in laboratory cupboard, but noted a slight change in color.

Nickerson [3] stored samples of six commercial varieties of cotton in fifteen locations in the United States. She reported a significant change in the depth of yellowness after 5 years; and found that location of storage influenced the degree of chroma change.

Simola [4] showed that exposure of cotton and worsted yarns to sunlight through a double glass for 5 months reduced the strength of cotton, 17.8 percent; and of wool, 7.3 percent.

These reports agree that storage causes change in color but differ as to effect on strength of textiles.

Materials

The cotton fabric used for this investigation was a bleached sheeting. The new cloth had 74 warp and 66 filling yarns to the inch and weighed 4.7 ounces per

[2] Figures in brackets indicate literature references at the end of this paper.

square yard. It contained 4.9 percent finishing material. [5, p. 27]

Some of this cotton sheeting was washed and desized before storing. It was washed in a neutral soap solution, with temperature maintained at 60° to 65° C., and rinsed thoroughly in warm distilled water to remove all traces of soap. The fabric was then treated with a starch and protein-solubilizing enzyme preparation [5], and thoroughly rinsed. The desized sheeting averaged 75 warp and 72 filling yarns per inch and weighed 5.0 ounces per square yard.

The linen fabric was a bleached sheeting, washed and desized by the procedure described for cotton. The desized linen had 56 yarns per inch in both warp and filling directions and weighed 5.2 ounces per square yard.

The wool fabric, a clear finished, bleached, all-wool, 2 up and 2 down even-twill serge, was degreased by extraction in a modified Soxhlet apparatus with alcohol, then with ether for 6 hours each, and finally washed with 12 rinses of distilled water at 50° C. The Soxhlet apparatus was so designed that the freshly distilled solvent was cool by time it reached the fabric. The degreased serge weighed 8.4 ounces per square yard and had 78 yarns per inch in warp direction and 72 in the filling.

Conditions of Storage

New and desized cotton, desized linen, and degreased wool fabrics were stored in the dark at room temperature which averaged 78° F. and ranged from 72° to 84° F. as recorded by a thermograph (Washington, D. C.). Desized cotton, desized linen, and degreased wool were also stored exposed to diffused light at the same temperature.

Samples stored in the dark were kept in an office cabinet. Some desized cotton and desized linen samples were stored in the cabinet unwrapped, whereas new cotton and other desized cotton and desized linen pieces were wrapped in worn cotton sheeting for protection against dust. Worn sheeting was used to avoid any deterioration due to possible impurities in paper. One set of degreased wool samples was wrapped in the worn

sheeting and placed in sealed containers to prevent moth infestation, and stored in the cabinet.

Desized cotton and linen and degreased wool fabrics exposed to diffused light were mounted inside Corex-D globes of the type used in the Fadeometer. These globes, which transmit ultra-violet light and protect the samples against dust, were placed on an open office shelf and rotated weekly to distribute the effects of light from the window over the entire sample.

Samples of the two cotton fabrics, the linen, and the wool also were stored at a high temperature to simulate attic conditions in the summer. For this purpose the materials, wrapped in worn sheeting, were kept in a sealed chest placed in a tunnel where the recorded temperature averaged 102° F.

Sampling

Before storage the cotton, linen, and wool fabrics were cut into rectangles, 8×10 inches, in such a way that no sample was taken closer to the selvage than one-tenth the width of the cloth. At each test period, three of these pieces of each fabric for each storage condition except that for diffused light were subjected to laboratory analysis. The three rectangles chosen at any one period for any one condition were selected so that the warp and filling yarns were not the same. Each cotton and linen piece supplied 2 warp and 2 filling breaking strength strips, and one determination for fluidity in cuprammonium hydroxide and copper number. Each wool piece furnished 2 warp and 2 filling breaking strength strips and one determination for cystine sulfur, moisture, and methylene blue.

Tests were conducted at regular intervals of 6 months for a 4-year period. Light reflectance determinations were made on each rectangle removed at the end of 0, 2, and 4 years.

For diffused light, rectangles 8 by 23 inches, two each of desized cotton, desized linen, and degreased wool were stored. Sufficient cotton or linen was removed at each test period to furnish a total of three fluidity measurements. Similarly, enough wool was removed to make

three sulfur determinations. The material for each separate determination from the sample exposed to diffused light was taken at random.

Methods

For the cotton and linen fabrics, breaking strength, light reflectance, fluidity in cuprammonium hydroxide, and copper number were determined to measure the physical and chemical changes produced by storage at different conditions. Breaking strength, elongation at break, light reflectance, cystine sulphur, moisture, and methylene blue absorption were used to measure wool deterioration.

All unwrapped cotton and linen samples removed at each test period were laundered prior to testing to remove any accumulated soil. The wrapped cotton and linen samples also were washed to permit a comparison of the values for the wrapped and unwrapped materials. The procedure used was one 5-minute suds at 30° C., one 10-minute suds at 30° C., and 10 rinses in warm distilled water. The samples were smoothed on a flat surface to dry, thus eliminating the need for ironing before testing. The wool was not laundered after storage and before testing since no wool samples were stored unwrapped.

Strips for breaking strength were cut 7 $\times 1\frac{1}{2}$ inches and raveled to exactly 1 inch. They were broken in a motor-driven Scott tester of the pendulum type [5]. For wool, the elongation at break also was determined using the autographic recorder attached to breaking strength machine. Light reflectance was determined at seven wave lengths using a partial spectrophotometer [6].

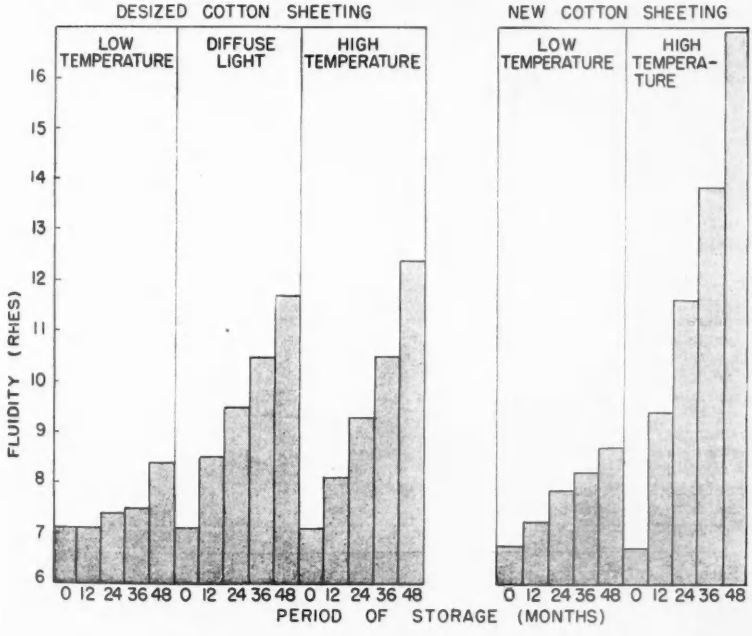
The fluidities of 0.5 percent dispersions of cotton and linen in cuprammonium hydroxide were measured at 20° C. in 5 ml. buret consistometers of the type described by Herschel and Bulkley [7]. The capillaries for the consistometers had an average inside diameter of 0.0963 cm. and an average length of 2.49 cm. The preparation, storage, and delivery of the cuprammonium solution were in accord with the recommendations of the American Society for Testing Materials [5]. The procedure employed for determining the fluidity was essentially the

FLUIDITY (RHES)

same as described by this society with the modification that the time of flow was obtained by a "split second" stop watch for 5 ml. portions of cuprammonium cellulose suspensions. Fluidity was calculated as described by American Society for Testing Materials and in addition a correction for velocity gradient [8] was made. For copper numbers 1.5-gm. samples of finely divided fabric were tested with Braidy's solution and heated at 100° C. in an oil bath thermostatically controlled [9].

The percentage of cystine sulfur was determined by Mease's method [10] in which the amount of sulfate sulfur is subtracted from that of total sulfur. Moisture determinations were made on a 2-gm. sample of conditioned wool heated to constant weight at 105° C. in bottles specially designed by Barritt and King and through which a current of dried air was passed during the heating process [11]. Methylene blue absorption was measured by the procedure of Elmquist and Hartley [12] in

Fig. 1. Fluidity in cuprammonium hydroxide of wrapped cotton sheeting stored for various lengths of time under different conditions.



which the unabsorbed methylene blue is titrated with napthol yellow S.

Results

Cotton.—In an analysis of variance, period of storage is not a significant [3] source of variation for the warp breaking strength of cotton sheeting but is for the filling strength (Tables I and IV). Condition of storage is significant for both warp and filling strength.

The fluctuations in the average breaking strength reported in Table I are due to the variability of the cotton sheeting. All of the strength determinations were made with the same testing machine in a laboratory maintained at standard conditions. Each value reported in Table I is an average of 6 determinations. More variation occurred among the 6 replicates warpwise than

TABLE I. Breaking strength, fluidity, and copper number of a cotton sheeting stored for various periods of time under different conditions[a]

Test method	Period of storage (months)								
	0	6	12	18	24	30	36	42	48
Breaking strength, warp (pounds):									
New fabric, room temperature, wrapped	53.5	56.6	52.8	55.4	56.3	55.8	57.2	54.5	56.0
New fabric, high temperature, wrapped	53.5	53.3	51.6	49.8	52.2	51.2	46.8	47.8	43.3
Desized fabric, room temperature, unwrapped	63.2	56.4	58.5	60.1	63.2	60.0	61.8	60.5	59.8
Desized fabric, room temperature, wrapped	63.2	58.5	55.7	64.3	57.1	61.8	60.5	57.1	58.8
Desized fabric, high temperature, wrapped	63.2	56.1	55.5	61.3	58.8	57.7	53.8	57.8	51.7
Breaking strength, filling (pounds):									
New fabric, room temperature, wrapped	53.2	50.9	49.8	48.1	51.2	51.2	51.4	46.1	46.1
New fabric, high temperature, wrapped	53.2	49.0	43.8	44.9	46.6	46.0	40.8	37.1	35.9
Desized fabric, room temperature, unwrapped	59.2	55.9	52.4	58.7	58.8	56.8	57.9	57.7	52.4
Desized fabric, room temperature, wrapped	59.2	60.4	56.0	56.3	60.8	56.9	57.8	56.7	53.2
Desized fabric, high temperature, wrapped	59.2	57.0	54.4	53.2	53.2	51.8	51.6	49.2	48.2
Fluidity (rhes):									
New fabric, room temperature, wrapped	6.79	7.38	7.23	7.78	7.80	7.84	8.19	8.33	8.7
New fabric, high temperature, wrapped	6.72	8.45	9.42	10.27	11.62	12.75	13.78	16.11	16.8
Desized fabric, room temperature, unwrapped	7.15	7.12	6.94	7.27	7.49	7.51	7.82	8.14	8.5
Desized fabric, room temperature, wrapped	7.11	6.83	7.10	6.82	7.42	7.39	7.53	7.72	8.0
Desized fabric, high temperature, wrapped	7.15	7.57	8.10	8.33	9.31	9.68	10.50	10.83	12.2
Desized fabric, room temperature, exposed to light	7.12	7.82	8.51	8.63	9.45	9.65	10.45	10.50	11.7
Copper number[b]:									
New fabric, room temperature, wrapped	.13	.14	.21	.20	.24	.26	.21	.25	.2
New fabric, high temperature, wrapped	.14	.26	.39	.47	.53	.54	.72	.74	.9
Desized fabric, room temperature, unwrapped	.12	.12	.17	.17	.20	.25	.20	.26	.2
Desized fabric, room temperature, wrapped	.12	.12	.17	.13	.19	.21	.20	.23	.3
Desized fabric, high temperature, wrapped	.14	.15	.27	.26	.34	.40	.40	.48	.6

[a] Each value reported for breaking strength is the average of 6 determinations and for fluidity and copper number the average of 3.

[b] Grams of copper reduced by 100 g dry cotton.

fillingwise. It is possible that the large variation in warp strength accounts for the failure to find the warp values significant for period of storage.

There are no more differences in the strength of unwrapped and wrapped sized cotton sheeting stored in the dark at room temperature than would occur by chance. Storing at 102° F. produced significantly greater loss in breaking strength than at 78° F. in both warp and filling direction for both new and desized sheeting as shown by individual comparisons. Also according to these comparisons, the new fabric containing finishing material was weaker than the desized sheeting in both directions and at both temperatures.

As measured by fluidity in cuprammonium hydroxide the cotton fabrics deteriorated chemically with storage (Fig. 1). Fluidity values for the materials kept at room temperature in the dark showed merely an upward trend with storage, while values for sheetings at the high temperature or exposed to diffused light increased steadily at each 6-month interval.

An analysis of variance of the fluidity data shows that both period and condition of storage are significant sources of variation.

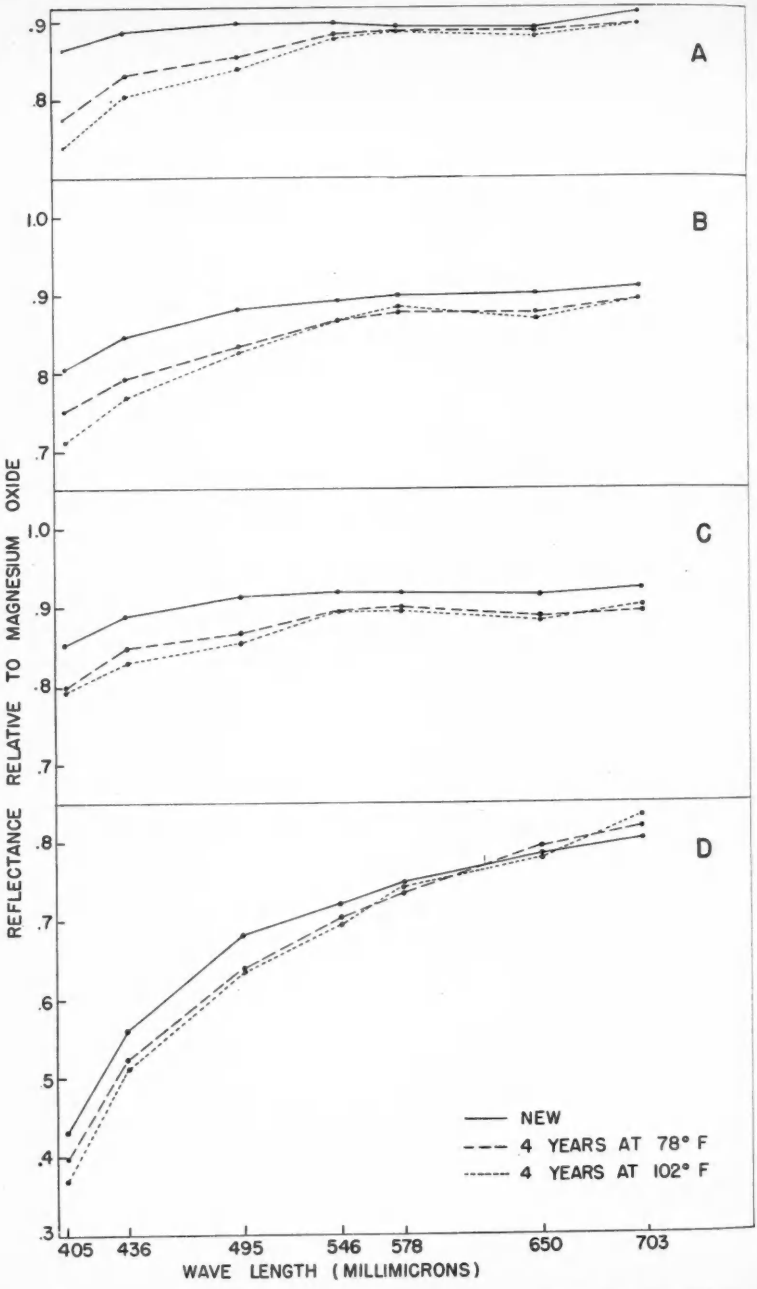
The actual fluidity value for the desized fabric stored in the dark at room temperature is lower for the wrapped than for the unwrapped samples but the difference is not significant according to individual comparisons.

Storage at 102° F. caused significantly more deterioration as measured by fluidity than at 78° F. This is true for both the desized and the new cotton (Fig. 1).

The new fabric was significantly more chemically damaged than the desized at the high temperature. This undoubtedly is due to the presence of finishing materials in the cloth. No variation occurred at the lower temperature greater than that due to chance.

According to the fluidity test the effect of diffused light on the cotton fabric was similar to that of heat. Under the conditions of this study, the grand average fluidity value of the desized cloth stored in the dark at

[3] No distinction is made between the 1-percent and 5-percent levels of significeance in this discussion.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REFLECTANCE RELATIVE TO MAGNESIUM OXIDE
NEW
4 YEARS AT 78° F
4 YEARS AT 102° F
405
436
495
546
578
650
703
WAVE LENGTH (MILLIMICRONS)

102° F. is the same as that exposed to diffused light at room temperature.

The copper number results also show that the cotton sheeting deteriorated chemically with storage. According to the analysis of variance both period and condition of storage are significant sources of variation.

Stored at room temperature in the dark, the wrapped sheeting was not significantly different from the unwrapped, although the actual copper number value is smaller for the wrapped as in the case of fluidity.

As shown by copper number, both the desized and the new cotton fabrics stored at the high temperature were significantly more deteriorated than the corresponding sheeting stored at the low temperature.

The new sheeting containing sizing was significantly more chemically tendered at the high temperature according to copper number than the desized cloth. The copper number of the new material increased from 0.14 to 0.83 during the 48-month storage period at the high temperature whereas that of the desized material changed from 0.14 to 0.61. However, at room temperature the presence of finishing material did not increase the amount of damage.

Forty-eight months storage reduced the surface light reflectance of both new and desized cotton sheeting, particularly in the blue end of the spectrum as shown in Fig. 2 (A and B). There was significantly more darkening for both sheetings after storage at 102° F. than at room temperature. There is no definite difference between the light reflectance values of the wrapped and unwrapped desized sheeting.

Linen

The breaking strength of desized linen sheeting when all conditions of storage are considered tended to decrease (table II). As shown by an analysis of variance, period of storage is a significant source of variation

Fig. 2. (See opposite page.) Reflectance relative to magnesium oxide at 7 wave lengths for various materials originally and after 4-years' storage, wrapped: A, new cotton sheeting; B, desized cotton sheeting; C, desized linen sheeting; D, degreased wool serge.

for both the warp and filling direction but condition of storage is not. As with cotton, the fluctuations in the average breaking strength values given in Table II result from the variability of the fabric.

Smaller changes were found in the fluidity values for the linen sheeting than for the cotton, although the fluidity values when averaged for all the conditions of storage of the linen sheeting increased, in general, with period of storage. Fluidity of the desized linen sheeting stored at high temperature for 48-months increased from 20.2 to 21.2 rhes whereas the corresponding values for the desized cotton sheeting are 7.15 and 12.35 rhes.

According to an analysis of variance, period and storage are significant main effects for fluidity. Individual comparisons show that there are no significant differences among the values for the wrapped and the unwrapped linen stored at room temperature and the wrapped fabric stored at 102° F.

The fabric exposed to diffused light was significantly more deteriorated chemically than that stored under the

TABLE II. Breaking strength, fluidity, and copper number of a desized linen sheeting stored for various periods of time under different conditions[a]

Test method	Period of storage (months)								
	0	6	12	18	24	30	36	42	48
Breaking strength, warp (pounds):									
Room temperature, unwrapped	104.5	102.2	101.0	100.2	104.6	102.7	102.2	99.4	91.
Room temperature, wrapped	104.5	102.2	95.5	103.6	103.6	106.8	104.9	104.5	92.
High temperature, wrapped	104.5	107.1	105.2	102.5	103.8	101.5	97.5	98.3	88.
Breaking strength, filling (pounds):									
Room temperature, unwrapped	91.6	97.3	87.7	88.2	93.3	89.1	82.6	89.3	78.
Room temperature, wrapped	91.6	85.0	84.7	91.8	92.4	95.3	84.5	91.6	81.
High temperature, wrapped	91.6	87.3	84.7	91.8	86.8	87.5	84.5	87.7	77.
Fluidity (rhes):									
Room temperature, unwrapped	20.2	20.0	20.3	20.3	20.5	20.7	20.5	20.7	19.
Room temperature, wrapped	20.2	18.9	19.4	19.8	20.0	20.2	20.2	20.1	20.
High temperature, wrapped	20.2	19.7	19.6	19.5	20.6	20.6	20.8	21.2	21.
Room temperature, exposed to light	20.2	20.5	20.8	21.2	22.3	22.1	22.8	22.6	23.
Copper number[b]:									
Room temperature, unwrapped	.52	.55	.53	.60	.52	.58	.52	.62	.
Room temperature, wrapped	.52	.57	.56	.58	.51	.53	.49	.63	.
High temperature, wrapped	.52	.64	.58	.68	.60	.61	.58	.67	.

[a] Each value reported for breaking strength is the average of 6 determinations and for fluidity a copper number, the average of 3.

[b] Grams of copper reduced by 100 g dry fabric.

three other conditions. At each of the eight periods of storage the fluidity value of the linen exposed to diffused light at 78° F. is greater than that of the samples stored in the dark at either temperature. However, the desized cotton sheetings stored in the dark at the high temperature and stored exposed to diffused light at room temperature were equally tendered.

As measured by copper number as well as fluidity there was less change in linen with storage than in cotton. An analysis of variance of the copper number data for the linen sheeting shows that period and condition of storage are significant sources of variation. As storage continued there was a tendency toward an increase in copper number.

No significant difference exists in copper number values between the wrapped and unwrapped linen stored at room temperature in the dark. However, the wrapped sheeting stored at the high temperature is significantly more chemically deteriorated than that stored at room temperature, wrapped or unwrapped.

Linen was darkened by 48-months storage as shown by light reflectance (Fig. 2, C) but the conditions of storage did not produce any greater difference than can be attributable to chance. As in the case of cotton, the greater changes occurred in the blue end of the spectrum at the 405, 436, and 495 millimicrons wave lengths.

Wool

The values for the breaking strength of wool serge reported in Table III show little change as a result of storage, although there are some fluctuations due to the variability of the material. Condition of storage in an analysis of variance is not significant (Table IV). Even though period of storage is mathematically significant for the warp direction, the increase is of no practical importance. There is no greater change in the percentage elongation at break for either condition or period of storage than would be expected from sampling variation.

In general the cystine-sulfur values of the wool decreased as the period of storage increased, which showed that the wool became more chemically deteriorated with

time. An analysis of variance shows that both period and condition of storage are significant.

Storage of the wool at the high temperature in the dark and storage at the low temperature exposed to diffused light caused significantly more deterioration than storage at the room temperature in the dark as measured by changes in cystine-sulfur content. Under the conditions of this experiment there was no significant difference between the wool kept in the dark at the high temperature and that exposed to diffused light at room temperature.

An analysis of variance of the moisture content values for wool shows that period but not condition of storage is a significant main effect.

TABLE III. Breaking strength, elongation, cystine sulfur, moisture and methylene blue absorption of a degreased wool serge stored for various periods of time under different conditions[a]

Test method	Period of storage (months)								
	0	6	12	18	24	30	36	42	48
Breaking strength, warp (pounds):									
Room temperature, wrapped	51.9	53.5	52.9	54.3	52.9	53.0	53.6	55.1	53.9
High temperature, wrapped	51.9	53.1	52.6	54.8	52.7	52.2	52.0	55.7	52.3
Breaking strength, filling (pounds):									
Room temperature, wrapped	43.5	45.5	44.9	46.7	45.9	44.2	43.5	44.2	41.8
High temperature, wrapped	43.5	43.4	43.8	45.2	44.8	43.6	44.8	44.8	42.9
Elongation at break, warp (percent):									
Room temperature, wrapped	49	44	42	43	41	44	42	43	47
High temperature, wrapped	49	44	42	42	40	42	42	43	44
Elongation at break, filling (percent):									
Room temperature, wrapped	48	43	39	42	43	41	42	42	43
High temperature, wrapped	48	41	38	42	42	39	43	41	44
Sulfur (percent):									
Room temperature, wrapped	3.71	3.67	3.57	3.59	3.53	3.51	3.42	3.44	3.3
High temperature, wrapped	3.71	3.70	3.56	3.47	3.51	3.43	3.44	3.31	3.2
Room temperature, exposed to light	3.71	3.69	3.54	3.56	3.51	3.42	3.40	3.32	3.2
Moisture (percent):									
Room temperature, wrapped	12.63	12.62	12.43	12.51	12.32	12.26	12.04	11.77	12.3
High temperature, wrapped	12.63	12.49	12.47	11.91	11.98	12.01	12.20	11.73	12.1
Methylene blue absorption[b]:									
Room temperature, wrapped	18.8	18.5	18.6	18.8	18.4	18.6	18.5	18.5	18.8
High temperature, wrapped	18.8	19.5	19.6	19.9	19.8	20.1	19 2	20.3	19.6

[a] Each value reported for breaking strength and elongation is the average of 6 determinations and for the chemical tests, the average of 3.

[b] Mols of methylene blue absorbed by 100 g of dry wool.

There is no definite trend in methylene blue values with length of storage. However, individual comparisons show that the wool stored at 102° F. was significantly more deteriorated chemically than that stored at room temperature.

The surface light reflectance of wool (Fig. 2, D) was reduced by storage. At the end of 4 years there was no significant difference between samples stored at 78° F. and those at 102° F. *(Continued on page 34.)*

TABLE IV. Analysis of variance of data from certain tests on a cotton, a linen, and a wool fabric stored under various conditions for different periods of time

Cotton

Source of variation	D/F[a]	Mean square			D/F[a]	Mean square
		Breaking strength		Copper number		Fluidity
		Warp	Filling			
Condition of storage	4	156.71**	268.10**	.1678**	5	25.25**
Period of storage	8	14.10	40.82**	.0646**	8	10.81**
Condition × Period[b]	32	6.47	5.15	.0062	40	1.37

Linen

Source of variation	D/F	Mean square			D/F	Mean square
		Breaking strength		Copper number		Fluidity
		Warp	Filling			
Condition of storage	2	3.22	13.82	.0104**	3	5.672**
Period of storage	8	53.27**	51.75**	.0049**	8	1.222**
Condition × Period[b]	16	8.52	9.54	.0005	24	.264

Wool

Source of variation	D/F	Mean square				D/F	Mean square
		Breaking strength		Methylene blue absorption	Moisture		Cystine sulfur
		Warp	Filling				
Condition of storage	1	.72	.64	4.810**	.100	2	.0080*
Period of storage	8	2.30**	2.13	.096	.142*	8	.0623**
Condition × Period[b]	8	.29	.71	.135	.026	16	.0017

[a] Degrees of freedom. [b] Error term.

* Indicates a significant variation, that is one which will probably occur 1 time out of 20 repetitions of the experiment.

** Indicates a variation with a probability of 1 time out of 100 repetitions.

Summary and Conclusions

Cotton sheeting both new and desized, desized linen, and degreased wool were stored in the dark at average temperatures of 78° F. and 102° F. for 4 years. The desized cotton and linen and the degreased wool also were stored in diffused light at 78° F. At the lower temperature, in the dark, the desized cotton and linen were stored, wrapped and unwrapped, and the wool wrapped. Before storage and at intervals of 6 months, breaking strength, fluidity, and copper number determinations were made on the cellulosic materials, and breaking strength, elongation, cystine sulfur, moisture, and methylene blue absorption tests on the wool for all conditions except exposure to diffused light. The deterioration of samples exposed to diffused light was evaluated by fluidity for cotton and linen and by cystine sulfur for wool. Changes in light reflectance were determined after 2 and 4 years of storage for all the fabrics under all conditions except exposure to diffused light.

No significant differences were found between the values for the wrapped and the unwrapped samples kept in the dark at room temperature for desized cotton and linen sheetings as measured by breaking strength, copper number, fluidity, and surface reflectance.

All tests used in this study showed that both the new and desized cotton sheeting were significantly more deteriorated when stored at the high temperature than at room temperature. According to filling breaking strength and copper number, linen stored at the high temperature was significantly more damaged than at the low, but for the other tests on linen stored at the two temperatures, no difference greater than that due to experimental error were found. Cystine sulfur, and methylene blue absorption determinations showed that wool stored at the high temperature was more chemically deteriorated than at the low.

Significantly greater changes occurred in the new cotton sheeting than in the desized during storage at the high temperature, according to all tests. Also during storage at the low temperature the new fabric had a lower breaking strength in both directions than the desized.

Storage in diffused light caused significantly more chemical deterioration than storage in the dark at the same temperature according to the fluidity measurement for cotton and linen and to cystine sulfur for wool. Under the conditions of this experiment, exposure to diffused light at room temperature produced as much change as exposure in the dark at the high temperature in the case of cotton and wool, whereas for linen diffused light caused more chemical damage than did the high temperature.

As a result of this study it is recommended that fabrics be stored in the dark, at as low a temperature as convenient, and free of finishing material.

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ABSTRACTS

ANALYSIS: TESTING: LABORATORY METHODS

Measuring Fiber Fineness

Measuring fiber fineness. M. A. Grimes. TEXTILE RESEARCH **13**, 12–8 (Nov. 1942).

The following is a correction of abstract that appeared in TEXTILE RESEARCH, *Feb. 1943, page 36.*

A new, rapid method of measuring fiber fineness consists in measuring the air permeability of weighed wads of cotton using special apparatus designed to make use of the principle employed by Sullivan and Hertel. However, the pressure diff. in the manometer is used as a measure of fineness rather than the calculated surface per gram used by Sullivan and Hertel. Data obtained in this manner show a good correlation with weight-per-inch measurements made on the same cottons. Samples of 36 cottons, ranging from 2.69 to 5.87 μg (micrograms) per inch, were studied. This method is rapid, the technique is simple, and the equipment is inexpensive. It is estd. that fiber fineness detns. can be made on 16–24 samples per day, allowing three measurements per sample. Only three to six weight-per-inch detns. can be made in the same period of time.

Fiber Measurement

The porous plug and fibre diameter measurement. 1. A practical method of wool fibre diameter measurement. A. B. D. Cassi. *J. Textile Inst.* **33**, T195–204 (Dec. 1942).

The plug method gives a simple and useful means of measuring the mean diam. of wool fibres provided these are free from kemp. The calculations required have been simplified as far as possible and a value is given for the shape factor which is applicable to plugs with parallel pores and a porosity around 35%. The density of wool must be taken as 1.35 gm./c.c. if the plug measurements are to give consistent values of diam. for different porosities. The thickness of any oil film on the fibres is included in the diam. deduced from plug measurements, and it is recommended that oil should be removed from the fibres before measurements are made. Plug measurements are sensitive to regain of the fibres, and it is essential that the wool should be conditioned and that the measurements should be made at constant temp. and rel. humidity.

Wear Testing of Cords

Abrasion test for textiles. A. C. Walker. *Bell Laboratories Record* **21**, 15–7 (Sept. 1942).

A rapid and reliable measure of the wearing quality of telephone cord braids is obtained by means of a new abrasion test on the textile yarns used in their construction. Threads, either singly or tied in endless loops, are suspendd frome hooks fastened to a stationary crossbar. Weights are hung from these threads and they are so arranged about staggered pins mounted on a vertically oscillating plate that the threads are twisted together in a sharply bent loop. As this plate moves up and down under the action of a motor-driven cam it rubs the threads against each other and wear occurs in the sharp bend. The cabinet which encloses the apparatus is air-conditioned for humidity and temperature by means of a simple, effective method. Seventeen specimens can be tested at a time. When a thread breaks, the weight hung from it falls on a balanced rod, actuating a switch to stop the motor which drives the oscillating plate. At the same time a signal lamp is lighted. A counter records the number of strokes. In measuring the

abrasion resistances of spun mercerized cotton used for telephone cord braids, the method just described gave results which checked within plus or minus 15% of the average for groups of 17 specimens. As a commercial inspection tool the apparatus can be arranged to automatically re-start itself after breaking each of the first eight specimens of a lot of 17, then stop after the 9th is broken, and the counter reading at this point gives the median value. Thus only one observation need be taken for a test on 17 specimens. As a research or development tool, statistical analyses of sufficient numbers of repeat tests may be used to great advantage in judging the uniformity of the material and as a guide in improving the manufacturing process.

Burning Tests for Textiles

Development of suitable fire tests for visual deception materials such as Osnaburg cloth. Ed. Schulte, L. Nusser, and P. Kunz. *Official Digest Federation Paint and Varnish Production Clubs*, No. 214, 123–34 (1942).

Sixteen well-known burning tests for textiles and wood are reviewed. A new method is described in which a sample 4 in. by 15 in. is placed horizontally on two fine Cu wires, clamped at one end, pulled taut with a 1 lb. wt. and then clamped at the other end. A heater contg. a 450-w heating coil (115 v.a.c.) is placed at one end of the fabric and 1 in. above the surface. When the fabric bursts into flames the heater is removed and the ignition time recorded. This is 9–9.5 sec. for untreated Osnaburg. The burning time and char area are also recorded. Results are given for plain Osnaburg and for Osnaburg treated with linseed oil-borax fire resistant paint, both being then treated with (1) 5% or 10% soln. $MgSO_4$ followed by a 3% or 6% soln. of borax-boric acid (7:3 mixt.), (2) 6% soln. of borax-boric acid, and (3) 10% soln. of sulfamic acid. Highest ignition time observed (17.5 sec.) was for unpainted samples treated with 10% $MgSO_4$ soln. followed by 6% borax-boric acid soln. while all painted samples exhibited about the same ignition times (15–17 sec.). Lowest burning times and char areas were exhibited by painted samples treated with 6% borax-boric acid soln. and 10% sulfamic acid. Ignition times are quite reproducible whereas burning times and char areas are somewhat less so.

Electron Microscopy

The electron microscopy of cellulose. R. B. Barnes and C. J. Burton. *Ind. Eng. Chem.* **35**, 120–5 (Jan. 1943).

Cotton fibers of various degrees of maturity were disintegrated mechanically until fragments small enough for examn. with the electron microscope were obtained. These were then examd. both with the electron instrument and with the optical microscope. By using a method which makes low electronic magnifications possible, a direct comparison of photomicrographs and electron micrographs was achieved. The fibrous nature of the cotton fibers is clearly illustrated in the electron micrographs. A comparison of these with the photomicrographs strongly suggests that certain apparent characteristics of cellulose which may be revealed in photomicrographs, are detd. by diffraction effects.

Fluidity Tests on Nylon

The fluidity of nylon solutions in *m*-cresol: measurement of chemical damage in nylon textiles. J. Boulton and D. L. C. Jackson. *J. Soc. Dyers and Colourists* **59**, 21–6 (Feb. 1943).

A viscosimetric method for the evaluation of chem. damage in nylon is

proposed. The most suitable solvent is *m*-cresol, and a study of the flow of nylon solns. in this liquid has been made. *m*-Cresol solns. of nylon exhibit Newtonian flow and show a Neale-Farrow viscosity-conen. relationship in which the constants have the values shown for a conen. range of 3.0% to 10.%.

$$\frac{1}{c} = \frac{0.357}{\log. V} - 0.105$$

Suitable dimensions for an efflux type viscometer are given, and a routine method is specified for the measurement of nylon fluidities. Data for degradation due to light exposure and acid attack are given, and a smooth relation is shown to exist in both cases between tensile strength and fluidity. Reproductibility and interpretation of fluidity results are critically examd. The first 50% of chem. damage due to Fadeometer exposure with the sample of nylon used corresponds to a rise of 15 fluidity units, and the same degree of damage due to mineral acid attack corresponds to a rise of 30 units. The fluidity unit is reciprocal poise $\times$ 100. The fluidity of 30 undamaged yarns of recent spinning varies between 20.0 units and 22.9 units.

Analysis of Rayon Mixtures

The quantitative analysis of cotton-viscose rayon mixtures. Frank P. Greenspan and Sidney M. Edelstein. *Am. Dyestuff Reptr.* **32**, 73–6, 98 (Feb. 15, 1943).

While convenient methods of sepn. exist for most fiber combinations, the analysis of cotton-viscose rayon mixtures has proved to be troublesome because of the chem. similarity of the two celluloses. The method here described makes use of the $Ba(OH)_2$ adsorption phenomenon, and it has been shown that a constant value of 100 for the Ba Activity Number is obtained for unmercerized cotton, while an av. value of 348 is obtained for viscose with an av. deviation of 3.7%. These small variations are related to such factors as fabric construction, yarn size, and dulling agents present. Analyses of a series of known mixts. are reported. The greatest error occurs when the % viscose is high. The exptl. details and a sample calcn. are given.

Starch Viscosity

Starch viscosity or strength. Willard L. Morgan and Norman L. Vaughn. *Ind. Eng. Chem.* **35**, 233–8 (Feb. 1943).

The fluidity funnel commonly employed throughout the starch producing industry and the exptl. factors affecting its use are examd. The strength funnel is not a true viscometer, and the strength scale varies in its relation to viscosity. A single unit of strength change from 0 to 20 represents an enormous change in true viscosity, whereas a unit change in the 80 to 100 strength range is only a slight change in viscosity. Apparent viscosity of starch pastes varies widely with the rate of shear used in the measuring viscometer. Apparent viscosity of starch pastes changes rapidly with conen. which indicates that the effect is largely mechanical. Graphs based on strength figures are often misleading. Plots of apparent viscosity figures during progressive modification by dextrinization, oxidation, and acid thin-boiling treatment result in simple type curves which clarify the nature of such changes. The com. variation in starches permit extremely large ranges of viscosity and solids combinations.

Water-resistance Tester

Water-resistant fabric utility. George A. Slowinske. *Am. Dyestuff Reptr.* **32**, 85–91 (Feb. 15, 1943).

A new impact penetration tester for water-resistant fabrics which is desig-

nated to measure the amt. of water penetrating a fabric under dynamic pressure is described. The sample is clamped on a stand inclined at 45° and over a piece of weighed blotting paper. 500 ml. of water are sprayed upon the sample from an av. height of 24 in. and the blotting paper quickly removed and weighed to the nearest 0.1 gm. Results of tests on 50 different fabrics by this method are given along with hydrostatic pressure and air permeability data. The fabrics used were all processed in the same manner and in the same plant under controlled conditions and differed only in construction. All samples rated 100 in water-repellency by the A. A. T. C. C. spray test. The results demonstrate that data from wetting tests, immersion tests, and hydrostatic pressure tests should be combined with that of impact penetration tests in order to obtain a complete over-all picture of a water-resistant fabric.

CHEMICAL AND PHYSICAL RESEARCH

Surface Active Agents

Surface-active agents. Foster Dee Snell. *Ind. Eng. Chem.* **35**, 107–17 (Jan. 1943).

The oldest surface-active agent is soap, whether made by saponification of fats with alkali or by neutralization of fatty acids with amines. Some of the latter types give a lower pH than soap. Sulfated castor oil is a sulfuric acid ester of glyceryl ricinoleate. Aliphatic sulfonates are represented by esters of sulfosuccinic acid. These are true sulfonates containing $-SO_2ONa$ rather than $-OSO_2ONa$. In both sulfated and sulfonated compds. the acid hydrogen is usually neutralized to give the sodium salt. Addition of a hydrocarbon side chain and a sodium sulfonate group to an aromatic nucleus forms the alkyl aryl sulfonates. Oleic acid chloride condenses with 2-chloroethylamine and, on subsequent treatment with sodium sulfite, gives Igepon T, $C_{17}H_{33}CONH(CH_2)_2SO_2ONa$. Quaternary amines, carrying high-mol.-weight hydrocarbon chains are cationic, whereas most types mentioned are anionic. Complex ethers and esters with long hydrocarbon chains are nonionizing types of surface-active agents and are also applicable in non-aqueous media. The great majority of surface-active agents have —COONa, $—OSO_2ONa$, or $—SO_2ONa$ as the water-attracting group, and a straight-chain hydrocarbon radical of the range C_8 to C_{18} as the water-repelling group. Related manifestations of surface activity are lowering of surface tension, reduction of interfacial tension, increase of wetting power, emulsification, and deflocculation.

Surface Active Agents

Surface active agents manufactured in America and commercially avaiable. F. J. Van Antwerpen. *Ind. Eng. Chem.* **35**, 126–30 (Jan. 1943).

A compilation of about 225 commercially available surface active agents in which is given the trade name, the type (in many cases the chem. compn.), the uses, the industries using the product, and the manufacturer's name.

Starch Analysis

Amylose and amylopectin content of starches determined by their iodine complex formation. F. Leslie Bates, Dexter French and R. E. Rundle. *J. Am. Chem. Soc.* **65**, 142–8 (Feb. 1943).

10 to 40 mg. of starch are dispersed in 10 ml. 0.5 *N* KOH, neutralized to methyl orange with HI and dild. to 100 ml. resulting in a soln. that is 0.05 *N* in KI. The soln. is titrated potentiometrically with 0.001 *N* I_2 in 0.05 *N* KI. It is shown that the two

components of starch are quite distinct in their reaction with I_2 to form complexes. Preliminary results indicate that the affinity for iodine varies inversely with the degree of branching of the starch chains and directly with the chain length. The method was standardized on the assumption that Kerr's "crystalline amylose," represents pure amylose. The results obtained in the analysis of representative starches are in good agreement with those obtained by the butanol fractionation method of Schoch.

Amylose Isolation

On the multiple amylose concept on starch. III. The isolation of amylose in crystalline form. Ralph W. Kerr and G. M. Severson. *J. Am. Chem. Soc.* **5**, 193–8 (Feb. 1943).

Procedures have been given for the isolation of a cryst. amylose from corn starch. Some of the properties of the amylose are given which relate it to a gamma-amylose and which show that it is a constituent of other corn amylose fractions recently reported. Its configuration is given as a linear arrangement of glucopyranose units. Corn starch is now believed to be made up of a series of components, a small percentage of which are crystallizable, relatively long in chain length and linear in constitution, others complicated with some branching, and the remainder very highly branched and quite amorphous in nature. While no product corresponding to gamma-amylose has been obtained from potato starch, the latter yields a cryst. fraction when its pastes are pptd. with alcohols. This fraction contains a cryst. amylose which can be isolated by procedures similar to those used with corn starch. An addnl. difference found between corn and potato starch is that potato starch contains a larger ratio of the more highly branched, amorphous fraction.

Strength of Yarn

A theoretical approach to the problem of yarn strength. R. R. Sullivan. *J. Applied Phys.* **13**, 157–67 (March 1942).

An idealized yarn composed of fibers with specified properties is treated analytically with the aim of detg. the yarn strength at any degree of twist. The results are presented in the form of equations and curves which relate the yarn strength to the fiber properties and the degree of twist. Two cases are studied: (1) all fibers alike; (2) fiber properties variable from fiber to fiber. In the latter case the mathematical expectation of the yarn strength at any yarn cross section is obtained. It is found that the optimum twist multiplier is largely determined by the fiber length, fiber fineness, and coefficient of friction, whereas the max. yarn strength (corresponding to the optimum twist multiplier) is more strongly dependent upon the intrinsic fiber strength than upon the other fiber properties studied.

Photochemical Stability

Photochemical stability of papers. Herbert F. Launer and William K. Wilson. *J. Research Natl. Bur. Standards* **30**, 55–74 (Jan. 1943).

Papers were irradiated with a carbon arc through a filter that completely eliminated infrared, and ultraviolet shorter than approx. 330 mμ. Sheet temp. was kept near 30° C. during irradiation, through contact with a thermostated metal backing, thereby eliminating heat effects, shown otherwise to overshadow light effects, using intense sources. In consequence, the results differed from those of previous workers. Yellowing of papers (without lignin) commonly ascribed to light was found to result from heat or age, but not from light; papers bleached when heat effects were eliminated during

irradiation. Even lignified paper was bleached by light in N. Paper scorched brown at high temps. or yellowed at 100° C., and yellow papers 250 yrs. old were bleached by light. Lack of O inhibits but does not altogether prevent photochem. deterioration. The role of water vapor differs fundamentally for cotton and wood-pulp paper. Lignified paper is very unstable to light. Printers' ink extensively protects paper. Irradiated papers are subsequently less stable in the dark than those not previously irradiated. The order of photochem. stability of papers was as follows: new-rag, refined sulfite, old-rag, soda-sulfite, and newsprint. The light stability of new-rag papers was greatly affected by acid and rosin, whereas that of old-rag and soda-sulfite was only slightly affected, in contrast to heat stability, for which pH is important for all fibers. Newsprint, made neutral with $NaHCO_3$, showed a large increase in light stability. Rosin did not seriously affect the stability of any papers as long as their acidity was low.

Reaction of Wool with Alkali

Nature of the reaction of wool with alkali. Louis R. Mizell and Milton Harris. *J. Research Natl. Bur. Standards* **30**, 47–53 (Jan. 1943).

The course of the reaction of the cystine in wool with alkali has been reinvestigated. The earlier findings that one sulfur atom is split from each mol. of cystine are confirmed. Of the residual noncystine sulfur in the alkali-treated wool, more than 25% has been accounted for as lanthionine. No significant amts. of sulfhydryl groups are in the treated wools. The results lead to the conclusion that the alkali cleavage of the disulfide group does not consist primarily in a hydrolytic rupture between the sulfur atoms with the formation of a sulfhydryl comp. and a sulfenic acid, as postulated earlier; rather, they are more consistent with a mechanism recently advanced by Nicolet and Shinn, which involves a rupture between sulfur and carbon to yield dehydroalanine and a $—CH_2—S—SH$ residue. An atom of sulfur is then eliminated from the latter and the sulfhydryl group thus formed reacts with dehydroalanine to form lanthionine.

Elasticity of Long Chain Molecules

The elasticity of a net work of long-chain molecules. I. L. R. G. Treloar. *Trans. Faraday Soc.* **39**, 36–41 (Jan. 1943).

The math. treatment of the elasticity of a molecular network by the method of Wall is compared with the earlier treatment of Kuhn. It is shown that a more accurate application of Kuhn's treatment leads to formulae for elongation and shear in agreement with those of Wall.

Chemically Modified Wool

Chemically modified wools of enhanced stability. Walton B. Geiger, F. F. Kobayashi, and Milton Harris. *J. Research Natl. Bur. Standards* **29**, No. 5, 381–9 (Nov. 1942); TEXTILE RESEARCH **13**, No. 1, 21–36 (Nov. 1942); *Textile Colorist* **64**, No. 768, 565–70 (Dec. 1942); *Ind. Eng. Chem.* **34**, No. 11, 1398–1402 (Nov. 1942).

Recent work has shown that the disulfide cross-linkages of wool can be transformed to more stable *bis*- thioether linkages by a two-step process. The disulfide groups are first reduced to sulfhydryl groups by means of a mercaptan, and then, by treating the wool with an aliphatic dihalide, pairs of sulfur atoms are linked together through short hydrocarbon chains. Wools modified by such a process have now been studied more extensively. It was found that they are

decidedly more stable than untreated wool toward many chemical agents, including alkalies, acids, oxidizing agents, and reducing agents; are stained less easily by metals; and are attacked much less readily by certain biological agents, including moths, carpet beetles, and enzymes.

DYEING: BLEACHING: FINISHING

Chrome Azo Dyes

The chemical constitution of the chrome azo dyes. Kenneth L. Dorman. *Am. Dyestuff Reptr.* **32**, 47–66 (Feb. 1, 1943).

The empirical and structural formulas, color, the mol. wts., the method of synthesis, and the Color Index and Schultz Nos. are given for 190 chrome azo dyes. By close inspection of the chrome azo dyestuffs it can be seen that several weak points exist. The greatest number of chrome azo dyes with good color and fastness characteristics is largely in dark blues, violets, blacks, browns and bordeaux. This is especially so when fulling, and potting characteristics are under consideration. The yellows are mostly reddish, or, at best, dirty greenish. The few chrome azo yellows made from acetoacetic ester derivates are clean and green, but leave much wanting in the matter of light fastness as compared to the other chrome azo colors. There are but few popular reds, especially bright reds. The brighter blues are largely oxazine or thiazine and are not chrome azo colors but colors of another type developed with chrome. These latter dyestuffs are bright but of not too great lightfastness. The greens are being improved. These, with the yellows and dull reds are of great importance in the production of khaki, olive drab, and other similar military shades.

Conserving Dichromate

Economy in the use of sodium dichromate when dyeing wool with mordant dyestuffs. L. P. Rendell. *Textile Colorist* **65**, 20 (Jan. 1943). (Reprinted from the *Textile J. of Australia.*)

The present shortage of $Na_2Cr_2O_7$ has made it advisable for dyers to reduce the amts. of this material used in chrome and mordant dyeing. This may be done safely, for in most cases, a large excess of $Na_2Cr_2O_7$ is used. Also, H_2CrO_4 imparts a yellow coloration to wool that fades rapidly on exposure, bringing about a marked change of tone, especially in greys. Expts. have shown that with the afterchrome process the shades produced by Solochrome dyestuffs, with one or two exceptions, can be fully developed with ½ $Na_2Cr_2O_7$ and 2% H_2SO_4. In mordant dyeing it has been found possible, with all except the heaviest shades, to reduce the amt. of $Na_2Cr_2O_7$ to 2%.

Direct Cotton Dyes

Direct cotton dyes, common salt, and common sense. C. M. Whittaker. *J. Soc. Dyers and Colorists* **58**, 253–6 (Dec. 1942).

The rapidity with which some direct cotton dyes exhaust in the presence of small amts. of salt or other electrolytes is a frequent cause of unlevel dyeing, particularly in package dyeing. When two or more dyes are used differences in tone from inside to outside of the package may result from too rapid exhaustion of one component. In the case of dyes with good affinity for the fiber in the absence of salt, the rate of dyeing may be markedly reduced by starting at a low temp. Hence, by strict control of the factors of temp. and salt concn. as well as the proper selection of dyes to be used simultaneously, the chief causes of unlevel dyeing with this class of colors may be elim-

inated. The amt. of salt added as a diluent to the com. dyes is frequently so great as to lead to too rapid dyeing rates. For this reason, the use of more concd. dyes is strongly advocated. The dyeing rates of a large no. of direct colors on viscose under controlled conditions are reported. The values given are the % exhaustion of the dyebath in 30 min. measured colorimetrically, and the "half-dyeing time" which is obtained geographically after plotting the % exhaustion vs. the log of the time (Boulton and Reading, *Ibid.* 50, 382 (1934)). On the basis of these data three distinct classes of direct dyes are defined, and the condition of temp. and salt concn. under which they must be dyed are described. Other data are given illustrative of the effect of time, temp., and salt concn. on particular dyes and combinations. These data show that dyes of different classes cannot be used simultaneously with success in package dyeing.

Indigo Piece Dyes

Dyeing woolen piece goods for the Navy—piece goods dyeing with leuco ester of indigo. Roland E. Derby. *Am. Dyestuff Reptr.*, 32, 30–2, 39 (Jan. 18, 1943).

Although the dyeing of Navy blue with indigosols topped with chrome colors is more expensive than the use of indigo itself, this is compensated for by the fact that no special equipment must be installed. It is particularly advantageous when dyeing rawstock to use indigosols as they have the property of being completely exhausted on wool and do not stain the machinery used subsequently as does indigo. The process described here is as follows: the goods from the loom are burled, mended, dryceaned, carbonized and fulled. After fulling Algosol Blue O is applied exactly as one would apply any acid color. After washing the indigosol is hydrolysed and oxidized to indigo. Two different formulae are given for topping this color with chrome dyes which bring the shade up to a match of the Navy standard.

Application of Latex

Application of rubber latex to woolen hosiery. G. H. Piper. *Rubber Chem. Tech.* 15, 895–904 (Oct. 1942). (Reprinted from *Trans. Inst. Rubber Ind.* 17, 301–14 (April 1942).)

The development of a process whereby rubber latex can be applied to woolen socks is discussed. By use of wetting and penetrating agents the latex is made to coagulate after it has penetrated the wool to a certain extent. When this treatment is applied to woolen socks, the abrasion resistance of the heel and toe areas is greatly improved. Furthermore, the woolen feeling is retained, and the finish is resistant to body warmth, perspiration and laundering. It is suggested that this process might be used to improve the phys. properties of synthetic protein fibers.

Synthetic Resins

Textile applications of natural and synthetic resins. M. H. Gurley, Jr. *Rayon Textile Monthly* 23, 726–7 (Dec. 1942); 24, 34–6 (Jan. 1943).

Synthetic resins not only are replacing the natural products but also are bringing about many new developments in textile finishing. Waterproof fabrics for military uses are now made with vinyl resins. Rubber, oil, and cellulose plastics also have been used, and it is expected that chemically modified rubber will become more important after the war. Crease-resistant textiles have been produced mainly by treatment with urea-formaldehyde resins. This process is best suited to regenerated cel-

lulose rayon, cotton, and linen. Increasing the durability of dress and industrial fabrics is an important function of resins. Shellac, rosin, gums, and rubber, all used for this purpose, are being rapidly displaced by cellulose lacquers, vinyl and urea-formaldehyde resins, and modified rubber. Alkyd and acrylic resins also are coming into use. Where color is relatively unimportant, inexpensive coal-tar products, such as cumar-indene, modified rosin, and terpene derivatives, may be used. In the finishing of hosiery to improve snag resistance vinyl polymers, acrylates, and polbutrene resins already have proved valuable. Wash-resistant glazed finishes can be produced by coating the fabric with a clear, flexible lacquer of cellulose plastics or an emulsion of alkyd resins, urea-formaldehyde condensates, acrylates, or vinyl compounds. Permanent stiffening can be achieved with cellulose acetate finishes, but recently vinyl resins have been found even more satisfactory because of their greater resistance to laundering. Synthetic resins are still too expensive to be used for loading, but small amts. of urea-formaldehyde resin will successfully bind to the cloth large amts. of cheap loading materials, such as starch and chalk.

Damage by Silverfish

Protecting textiles from silverfish. C. L. Mantell and E. May. *Modern Plastics* **20**, No. 6, 51–3, 120 (Feb. 1943).

Fabrics in storage are frequently damaged by silverfish, *Lepisma saccharina*, or by the firebrat, *Thermobia domestica*. These insects are attracted to the fabric by some types of sizing materials but consume both fiber and size. In the experiments described 8 fabrics were exposed to silverfish under optimum conditions of moisture and humidity, and both in the presence and absence of other food. The samples were examined and photographed at 20, 40, and 60 day intervals. After 60 days the following fabrics exhibited no damage: all rayon, finish removed; all rayon, finished with urea-formaldehyde and small amt. of casein; all rayon, finished with urea-formaldehyde by Arkwright method; all cotton, finish removed, and all cotton, treated with Cooper's gelatin. The samples exhibiting damage were: all rayon, finished with casein and resin (not of urea-formaldehyde type); cotton and rayon marquisette with starch finish, both dyed and undyed. When the goods were finished with starch the insects destroyed them even when there was other food present.

Insect Damage

Pest damage to silk. Eric Hardy. *Silk and Rayon* **17**, 38 (Jan. 1943).

Silk is not usually attacked by clothes moths, which prefer keratinous material like wool, but it may be attacked if the finishing material contains protein, or if moth larvae on nearby material are short of silk for their cocoons. There may be some damage in storage by mice, and rayon may be attacked by cockroaches, crickets, silverfish, Ptinidae beetles, red spider, earwigs, grain beetles, and other pests. Raw waste silk is attacked by the Larder beetle, *Dermestes lardarius*, the carpet beetle, *Anthrenus vorax*, and the red-legged Necrobia, *Necrobia rufipes*. Dermestes beetles can be destroyed by exposing the material to a temp. of 140° F. for an hr. Chloropierin, ethylene oxide, perchlorethylene, the pyrethrins, and roteone, and temp. control are all effective against the carpet beetle. One of the most effective ways of getting rid of the warehouse pests mentioned is spraying with 1.6% pyrethrum extract in a highly refined white oil. Proper storage of goods and adequate ventilation to keep temp. and humidity low will usually reduce insect activity.

Mildewproofing

Mildewproofing treatments for textile fabrics. Eric Croen. *Cotton* **107**, No. 2, 104–7, 118 (Feb. 1943).

A review of methods of mildewproofing that are applicable to the various military fabrics. Among the methods described are those employing copper naphthenate, cuprie ammonium fluoride, cuprie ammonium hydroxide, zinc naphthenate, pentachlorophenol, orthophenyl phenol, and phenyl mercurie acetate.

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

Cotton Fiber Bundle Strength

Strength of cotton fiber bundles. R. W. Webb. TEXTILE RESEARCH **13**, 18–21 (Feb. 1943).

The value reported by Matthews, 53,400 lbs. per sq. in., for the tensile strength of cotton fibers is too low. Measurements made by the U. S. Dept. of Agriculture on thousands of samples of various cottons and using both the Chandler and the Pressley methods have resulted in the following average values: 80,000 lbs. per sq. in. for American upland cotton with max. observed values of 106,000 lbs.; American Egyptian, 85–90,000 lbs.; Sea Island, 95–110,000 lbs. To det. the effect of twist on the strength of a bundle of cotton fibers, fiber bundles were tested contg. 1, 2, 3 and 4 turns per bundle or 1.60, 3.20, 5.33 and 8.00 twists per in., respectively. The respective ave. fiber bundle strengths which were obtained were 93,500, 80,200, 65,900 and 48,100 as compared with 98,900 lbs. per sq. in. for the control contn. no twist. The coefficient of correlation between fiber strength and twist of bundle was —0.99.

Natural Fibers

Some fibers and possibilities of their development in Western hemisphere. II. John Z. Williams. *Cord Age* **39**, No. 2, 12–3 (Feb. 1943).

Among the fiber plants under cultivation in Brazil are *Urena lobata L.*, and *Pavonia malacophyla*, the fibers of which are variously known as guaxima, vacima, malva veluda, and aramina. Others are *Hibiscus cannabinus* (poppy), *Neoglaziovia variegata* (caroa), *Corchorus capsularis* (jute), *Ananas erectifolius* (curuana), and the unclassified Juta paulista which appears to be a species of *Hibiscus*. Most plantings of these are for experimental purposes. The bulk of the commercial fibers are from plants growing wild such as piassava from the palms, *Attalea funifera* and *Leopoldina piassaba*, and piteira from the *Fourcroyl gigantea*. Other fiber plants growing wild include New Zealand flax and ramie. The fibers now receiving greatest attention for cultivation are the soft fibers of the genus *Hibiscus*.

Mohair and Cashmere

Mohair and cashmere fibers. A. C. Whitford. *Textile Colorist* **65**, 1–4 (Jan. 1943).

A review of the history, sources of supply, properties, and uses of these two fibers. Mohair, from the Angora goat, is divided into two main grades, Kid Mohair and Goat Mohair. The subdivisions of these two grades, together with the av. fiber diams., are tabulated. American Mohair, while shorter than Turkish Mohair, has a better appearance and is considered equal to, if not superior to, any grown elsewhere. Mohair differs from wool in microscopic structure, e. g., the scales differ in number, size and appearance, mohair having fewer, larger, but less prominent scales. Mohair is more nearly round in cross-

section. The finer grades are used in wearing apparel, while the coarser grades are used for upholstery. Cashmere, from the Cashmere goat, comes principally from China and India, and an inferior grade from Iran. For various reasons the production of this fiber is not over 200,000 lbs. per year. Cashmere consists of two fibers, the long, coarse, beard fibers, and the shorter, finer, undercoat fibers or noils. In contrast to wool and mohair, it is the noils that are highly prized. They are obtained by combing. Like mohair, cashmere is round in cross-section and contains no medulla. The scales project more than in mohair, giving it better felting properties, and they are smaller and more numerous. Cashmere is used in making the highest grades of garments and shawls.

Man-made Fibers

A symposium of man-made fibers. Part I. Joseph Leeming, James K. Hunt, Henry E. Millson, and William H. Page. *Textile Colorist* **65**, 9–14, 46 (Jan. 1943).

A symposium consisting of separate reviews of viscose rayon, nylon, aralac, and fiberglas. The history, method of manufacture, uses, dyeing qualities, and some of the chief phys. properties of each of these fibers are given.

Milkweed Fiber

Milkweed instead of kapok. Boris Berkman. *Textile Colorist* **65**, 45 (Jan. 1943).

Abstract of an address by author before the 8th Annual Chemurgic Conference. Microscopic and other data show that milkweed floss is so similar in every way to kapok as to be practically identical. Its development in the past has been hindered by the low cost of kapok, and the lack of a mech. method for opening the milkweed pods and separating the fibers from the seeds. The present unavailability of kapok and the recent development of the milkweed gin have removed these two barriers to the domestic development of this fiber.

Properties of Bubblfil

Bubblfil's development, properties, and uses. J. B. Quig. (TEXTILE RESEARCH **13**, No. 3 (Jan. 1942); *Am. Wool and Cotton Rptr.* **57**, No. 1, 9–10, 16 (Jan. 7, 1943).

Bubblfil has the advantage over kapok of being more versatile. Its properties may be varied over a wide range and in addition, it may be spun and woven. It retains its buoyancy considerably better than kapok during periods of immersion. The densities of bubblfils, ranging in denier from 680 to 4050, ranged from 7.3 to 1.4 lbs. per cu. ft. while that of kapok is 19.4 lbs. per cu. ft. For the same packed wt., samples of bubblfils had buoyancies slightly lower than kapok. These and other comparative data are tabulated.

Yarn Conditioning

Yarn conditioning for processing. G. Ullman. *Textile Colorist* **65**, 23–5, 41 (Jan. 1943). (Reprinted from *Textile Mfr.*)

Cotton yarn leaves the spinning department with a moisture regain of usually no more than 4–5% and it frequently becomes desirable to increase this about 8½%. Five methods of humidifying yarn are described and criticised, viz., the immersion, steaming, sprinkling, cellar conditioning, and mechanized conditioning methods. Only the last two are recommended as the others cannot be properly controlled and frequently result in yarns being unevenly humidified or covered with dew. It appears that humidification systems, such as ordinarily used in weave rooms, do not succeed in im-

parting to yarn the expected and desirable moisture regain. The reason is that diffusion of moist air to the yarns on the interior of a bobbin is very slow. In order to attain the highest possible strength, elasticity, and smoothness in filling yarns, it is recommended that they be conditioned to about 15% H_2 content in a mechanized moist chamber.

Deterioration of Cellulose Insulation

Factors affecting the mechanical deterioration of cellulose insulation. F. M. Clark. *Electrical Eng.* **61**, No. 10, 742–9 (Oct. 1942).

The rate of mech. deterioration of cellulose insulation is dependent on the conditions of its use, the factors of major importance being temp, oxygen, and moisture. Moisture, even in small amt., greatly affects the mech. stability. In general, the mech. life of the insulation is reduced by half for each doubling in H_2O content. Deterioration promoted by oxidn. is most effective at temp. below 120° C. and is accelerated by the presence of moisture. The rate of deterioration for substantially dry insulation at temp. above 120° C. is dependent upon its previous history. Intermittent exposure to high temp. effects are additive. The "eight-degree-centigrade rule," indicative that the rate of mech. deterioration is doubled for each 8° C. increase from a base temp. of 120° C. or higher, applies most closely for practical use when the insulation under study has lost more than 50% of its tensile strength.

Spinning Frame Tapes

Spinning frame tapes. Durant Anthony. *Can. Textile J.* **59**, 38, 41–2 (Nov. 6, 1942).

In mills that use tape driven spindles too little attention may be given to the proper adjustment and care of these tapes. The results are excessive wear, expensive stoppages, and low quality yarn. Tapes should be sewn, as patent tape fasteners do not give the same period of service. The tape should not be allowed to touch the flanges of the tension pulley. At no time should the tape, as it passes over the cylinder, be allowed to touch it. Neglect of both of these points leads to rapid fraying and wearing out of the tapes. It is important to cut tapes the proper length, for if they are too long, the tension pulley cannot take up all of the excess and slackly twisted yarn is likely to result, while if they are so short that they must be forced into position, the excessive strain causes them to wear out more quickly.

Winding Practice

Cheeses for pressure yarn dyeing. D. C. Hardman. *Textile Mfg.* **68**, 408–9 (October, 1942).

Winding of cheeses for machine dyeing is unsatisfactory and should be controlled to reduce the wide differences in package sizes, density, and angle of wind. The trend to open-wind wide angles is condemned.

Rayon Weaving

Useful hints on quality and quantity in the weave room. Leo Schlessinger. *Rayon Textile Monthly* **24**, 64–6 (Jan. 1942).

A type of unevenness sometimes found in the region of the selvedges and disappearing toward the center of the cloth is caused either by worn cutters or by the temple rolls becoming clogged with filling waste. Filling-wise ridges that sometimes appear in fine satin fabrics are due to irregular shedding which may in turn be due to defective harness springs or to worn cam rolls. Tight or slack picks appearing in a finished fabric may sometimes be traced

to the improper technique of the weaver or fixer in starting up the loom. When using such delicate yarns as 100 denier acetate filling on large bobbins and too high speed looms, such defects as slack picks, broken picks and chafed picks are frequently observed. Another frequent cause of trouble in weaving rayon is poorly beamed warps and poorly wound filling bobbins.

Tendering of Cotton Fabrics

The problem of tendering of cotton fabrics. Lt. Col. F. M. Steadman. TEXTILE RESEARCH **13**, 15–9 (Dec. 1942); *Am. Wool and Cotton Rptr.* **57**, No. 2, 7–8 (Jan. 1943).

The bleaching, scouring, and dyeing operations cause a certain amt. of degradation of cotton fibers that shorten the useful life of the fabric. The Army Q.M.C. is interested in further study being made of the factors leading to this degradation with a view of minimizing it. The problem of acid degradation of cellulose is of interest to the Q.M.C. because certain materials are impregnated with agents designed to neutralize mustard gas, the reaction releasing small amt. of acid in the fiber. The extent of damage to the fiber by this acid has been found to be roughly proportional to the extent of bleaching. It is suggested that certain types of degradation may so modify cellulose as to accelerate attack by acid with resulting rapid and severe tendering. Other problems in which the Q.M.C. is intensely interested are concerned with the prepn. for dyeing of herringbone twills, the relative sensitivity of mature and immature cotton to oxidizing agents, the effects of certain dyes on the future tendering of cotton, as well as several problems concerned with the use of waterproofing, water-repellant, mildewproofing and mothproofing agents.

Color Fastness of Dress Fabrics

The color fastness of certain types of dyes on women's and children's wearing apparel fabrics. Helen Elizabeth Borton, Carol Beth Walker, Pauline Beery Mack, and Charles A. Seibert. *Am. Dyestuff Reptr.* **31**, 603–27 (Dec. 1942).

A progress report on the color-fastness of 1,000 fabrics, containing 2,117 color areas, and on 211 worn-out garments made therefrom. The dyes on the fabrics have been analyzed as to dye type, the fabrics for fiber content, and the fabrics have been subjected to 13 tests for color-fastness. The performance of the dyed areas in the fabrics have been grouped as to fiber content type, dye type, and spectral range of the color, and the results of the tests have been presented in a series of graphs. A comparison of the laboratory with the wearing color-fastness for the 211 worn-out garments have been reported. Aside from the data on the relationship of color performance to dye types, the following conclusions are suggested. The 40-hour lab. fading test for color-fastness to light is not sufficiently rigorous to predict wear performance accurately. Performance in wash-fastness can be predicted in a high percentage of the cases. This calls for an accelerated laundry test, or for multiple washings. The technique of comparing consumer wear with lab. findings offers a means of improving current lab. tests for color-fastness so that they will simulate wear more closely.

Correction

Weaving O.D. Army Overcoatings. W. G. Holman.

An abstract of this article was carried in the March issue of TEXTILE RESEARCH, Page 46, in which the reference was incorrectly given. The publication carrying the original article was *Textile World*, Jan. 1943.